

CLIMATOLOGICAL DATA FOR JAMAICA.

Through the kindness of Mr. Maxwell Hall, the following data are offered to the MONTHLY WEATHER REVIEW in advance of the publication of the regular monthly weather report for Jamaica:

Jamaica, W. I., climatological data, September, 1901.

	Nerl Point Lighthouse	Morgan Point Lighthouse
Latitude (north)	18° 15'	17° 55'
Longitude (west)	78° 23'	78° 10'
Elevation (feet)	88	8
Mean barometer { 7 a. m.	29.884	29.884
{ 8 p. m.	29.889	29.881
Mean temperature { 7 a. m.	80.1	.....
{ 8 p. m.	84.0	.....
Mean of maxima	86.8	.....
Mean of minima	74.8	.....
Highest maximum.	90.0	.....
Lowest minimum.	71.0	.....
Mean dew-point { 7 a. m.	74.7	.....
{ 8 p. m.	74.3	.....
Mean relative humidity { 7 a. m.	84.0	.....
{ 8 p. m.	78.0	.....
Total rainfall (inches)	15.69	8.23
Average wind direction { 7 a. m.	se.	var.
{ 8 p. m.	se.	var.
Average hourly velocity, miles { 7 a. m.	11.7	6.4
{ 8 p. m.	11.8	10.6
Average cloudiness (tenths):		
7 a. m. { Lower clouds	1.9	1.7
{ Middle clouds	8.8	2.1
{ Upper clouds	1.9	1.0
8 p. m. { Lower clouds	2.8	2.2
{ Middle clouds	5.6	2.4
{ Upper clouds	0.5	1.2

Note.—The pressures are reduced to standard temperature and gravity, to the Kew standard, and to mean sea level. The thermometers are exposed in Stevenson screens.

Comparative table of rainfall for September.

(Based upon the average stations only.)

Divisions.	Relative area.	Number of stations.	Rainfall.	
			Average.	1901.
Northeastern division.	25	21	11.34	8.84
Northern and subcentral division	23	55	6.84	5.47
Western-central division.	25	24	12.80	10.26
Southern division.	27	33	11.92	6.37
General means.	100	132	10.60	7.61

In taking the average rainfall Mr. Hall uses only those stations for which he has several years of observation, so that the column of averages represents fairly well the normal rainfall for each division, while the column for the current month represents the average rainfall at those same stations. The relative areas of the divisions are very nearly the same and are given in the preceding table as expressed in percentages of the total area of Jamaica. The number of rainfall stations utilized in each area varies slightly from month to month, according as returns have come in promptly or not, but will not differ greatly from the numbers in the second column of the table.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index

of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

Journal of the Franklin Institute. Philadelphia. Vol. 152.

Pawling, Jesse. Notes on Magnetic Curves. Pp. 269-275.

— Use of Kites in Meteorological Work. Pp. 313-314.

Stradling, George Flowers. Recent Advances in the Physics of Water. Pp. 257-268.

Scientific American. New York. Vol. 85.

— The Ezekiel Airship. P. 228.

— A new System of Wireless Telegraphy. P. 230.

Das Wetter. Berlin. 18 Jahrg.

Brennecke, W. Neue Drachenversuche in Amerika. Pp. 214-215.

— In Gewitter. Pp. 212-214.

Sieberg, A. Einige Bemerkungen über Haloerscheinungen. Pp. 207-212.

Stade, Hermann. Die Niederschlagsmessungen auf Berggipfeln. Pp. 201-205.

Schnippel, G. Ein Sonnenuntergang in Verbindung mit Lufts piegelung. Pp. 193-200.

Geographical Journal. London. Vol. 18.

Arctowski, Henry. The Antarctic Voyage of the "Belgica" during the years 1897, 1898, and 1899. Pp. 353-395.

Ravenstein, E. G. The Lake-Level of the Victoria Nyanza. Pp. 403-406.

L'Aerophile. Paris. 9me Année.

— Des Expériences de Santos-Dumont. Pp. 181-212.

Philosophical Magazine. London. 6th Series. Vol. 2.

Fraser, W. G. On the Breaking of Waves. Pp. 356-361.

Barus, O. The Transmission of the Emanations of Phosphorus through Air and other Media. Pp. 391-403.

Journal de Physique. Paris. Tome 10.

Livingst, S. D. and Dewar, J. Sur le spectre de la partie la plus volatile des gaz de l'atmosphère qui ne sont pas condensés à la température de l'hydrogène liquide. P. 615.

La Nature. Paris. 29me Année.

Roger, Em. Halo solaire. P. 295.

G. G. La vitesse de l'air. P. 314.

Boletin de la Oficina Agricola Ganadera. La Plata. Tomo 1. 1901.

Lemee, C. La prévision del tiempo. Pp. 282-288.

Annalen der Physik. Leipzig. Vierde folge. Band 6.

Eschenhagen, M. Werte der erdmagnetische Elemente zu Potsdam für das Jahr 1900, sowie der Säcularvariationen für die Zeit von 1890 bis 1900. Pp. 424-428.

Toeppler, M. Einfluss von Diaphragmen auf elektrische Dauerentladung durch Luft von Atmosphärendruck. Pp. 339-347.

Tamm, Franz. Ueber den Einfluss des Luftdruckes und der Luftfeuchtigkeit auf die Entladung statischer Elektricität aus Spitzen. Pp. 259-279.

Ciel et Terre. Bruxelles. 22me année. 1901.

Vandevyver, —. Action de l'électricité sur le brouillard. Pp. 364-371.

Annalen der Hydrographie und Maritimen Meteorologie. Hamburg. 29 Jahrg.

Grossmann, —. Die Extremtemperaturen in Hamburg in den Jahren 1876 bis 1900. Pp. 463-467.

— Die Witterung zu Tsingtau in den Monaten vom Januar bis Mai 1901. Nach den Aufzeichnungen und einem Bericht der Kaiserlichen meteorologisch-astronomischen Station zu Tsingtau. Pp. 459-463.

Dinklage, L. H. Orkan im östlichen Theile des nordatlantischen Passatgebietes im September 1900. Pp. 457-458.

— Aus den wissenschaftlichen Ergebnissen der Polarfahrt des "Matador" unter Führung des Kapt.- Leut. a. D. Oskar Bauendahl, Herbst und Winter 1900-1901. Pp. 445-457.

Illustrirte Aeronautische Mittheilungen. Strassburg. Oktober 1901.

— Der Flugapparat von Gustav Weisskopf. P. 165.

Koeppen, W. Beiträge zur Mechanik des Fluges und schweden Falles. Pp. 149-160.

Evert, Hermann. Magnetische Messungen im Ballon. Pp. 137-146.

Steffen, Karl. Das flugdynamische Prinzip. Pp. 160-162.

Aeronautical Journal. London. Vol. 5.

Alexander, Patrick Y. Sounding the Air by Flying Machines controlled by Hertzian Waves. P. 59.

Rotch, A. Lawrence. The Chief Scientific Uses of Kites. Pp. 56-59.

Journal of School Geography. Lancaster. Vol 5.

Russell, I. C. Climate, Vegetation, and Drainage of Cascade Mountains of Northern Washington. Pp. 281-289.

Journal Manchester Geographical Society. Manchester. Vol. 17.

Wragge, Clement. The Snowy Ranges of Australia, Mount Kosciusko and its Observatory. Pp. 111-124.

- Synons' Meteorological Magazine. London. Vol. 36.*
 Ravenstein, E. G. Climatology of Africa. Pp. 146-148.
 Dickson, H. N. Mean Temperature and the Causes of Glacial Periods. Pp. 145-146.
 Shaw, W. N. Sea Temperature and Variation of Air Temperature in British Isles. P. 145.
 Shaw, W. N. Weather Maps. Pp. 144-145.
 Shaw, W. N. Variations in Temperature in British Isles in relation to Wind. Pp. 142-144.
- Archives des Sciences Physiques et Naturelles. Genève. Tome 12.*
 Gautier, R. Observations météorologiques faites aux fortifications de Saint-Maurice pendant l'année 1899. Pp. 265-300.
- National Geographical Magazine. New York. Vol. 12.*
 Moore, Willis L. The Weather Bureau. Pp. 362-369.
- Gaea. Leipzig. 37 Jahrg.*
 — Über den Einfluss des Luftdruckes auf das Blut. P. 696.
 — Die meteorologischen Veränderungen infolge einer Sonnenfinsterniss. Pp. 694-695.
 — Die untersuchung der Gewitter und Hagelfälle in Bayern. Pp. 662-668.
 — Die bisherigen Forschungsreisen im südlichen Polargebiete. Pp. 657-662.
 — Meteorologie und Seeschiffahrt. Pp. 651-657.
- Meteorologische Zeitschrift. Wien. Band 18.*
 Draenert, F. M. Das Höhenklima von Uberaba, Central-Brasilien. Pp. 385-406.
 Martin, K. Der Regen in Südchile. Pp. 406-412.
 Exner, K. Optisches Vermögen des Ortes. Pp. 412-413.
 Paulsen, A. Ueber die Identität eines Theiles des Nordlichtspektrums mit dem entsprechenden Theile des Kathodenlichtspektrums des Stickstoffes. Pp. 414-415.
 — Ueber die Perioden des Südlichtes. Pp. 415-416.
 Hellmann, G. Die ältesten meteorologischen Beobachtungen aus St. Petersburg. Pp. 416-417.
 Stevenson, J. Die chemische und meteorologische Geschichte der Atmosphäre. Pp. 417-420.
 Steiner, L. Zum jährlichen Gang des Luftdruckes in der Höhe. Pp. 420-423.
 Rossler, C. Grösste Regenmengen innerhalb 24 Stunden. P. 423.
 — Regenfall im Kapland. P. 423-424.
 Hecker, O. Ueber die Konstanz von Siedethermometern aus dem Glase 59. Pp. 424-426.
 Buhrer, C. Einfluss der Geschützfeuer auf die Regenbildung. P. 426.
 — Insektenregen. P. 426-427.
 Mack, K. Blitze mit deutlich erkennbarer Fortpflanzungsrichtung. P. 427.
 — Luftspiegelung. Pp. 427-428.
 Krebs, W. Atmosphärische Optik im Elsass. III. P. 428-429.
 — Sonnenscheindauer in der Schweiz. P. 429.

THE GENERAL CIRCULATION OF THE ATMOSPHERE, ESPECIALLY IN ARCTIC REGIONS.¹

By H. H. KIMBALL, Weather Bureau.

The circulation on an ideal planet.—The problem of the general circulation of the atmosphere "on the earth as it really is" has long engaged the attention of eminent physicists and meteorologists, but on account of its complicated character its complete solution is yet to be given. On page 300 of the present volume of the MONTHLY WEATHER REVIEW, Marcel Brillouin has presented a brief résumé of some of the more important papers bearing on this subject. As this writer shows, there have not been wanting elaborate analyses of the atmospheric motions that would take place on an ideal earth, one, for instance, having a homogeneous frictionless surface, and with the temperature diminishing uniformly with latitude and elevation, but having no temperature variation with longitude. Of this class of investigations he says:

From this point of view no memoir can compare with that of von Helmholtz. He seems to me to have exhausted the subject that he treats of, "The circulation of a dry gaseous atmosphere upon a polished globe, revolving like the earth." But this is not the last stage; we must find a rigorous treatment of the problem * * * of the atmospheric circulation upon the earth as it really is.

It will certainly assist in the solution of this problem if we ascertain wherein the circulation on an ideal planet dif-

¹ Abstract of a thesis submitted for the degree of *M. S.*, Columbian University, Washington, D. C., 1900.

fers from the actual circulation on our globe, as shown by observations.

At no point, perhaps, does one theory differ more from another, or theory depart farther from fact, than in regard to the circulation in arctic regions. Thus, Ferrel² showed that, assuming the earth to be a rotating frictionless sphere, with no temperature inequalities upon its surface, if the air were at rest it would remain at rest, unless set in motion by some force. If a force act to produce motion along a meridian in the direction of the pole, the rotation of the earth would deflect it toward the east, and the deflecting force would so accelerate the easterly motion as the pole was approached that an infinite velocity would be attained, and the barometric pressure would be reduced to zero. Friction causes the actual pressure to be far greater than zero.

Assuming a diminution of temperature with latitude, but no temperature variation with longitude, a meridional flow toward the pole would be established which would immediately be deflected toward the east, and would be accelerated as the pole was approached. Its velocity would also increase with the altitude, and would attain to infinity before reaching the pole unless retarded by friction.

Oberbeck³ assumed a homogeneous rotating sphere, with an upper boundary surface for the atmosphere at an undetermined height, except that the ratio between H , the height of the atmosphere, and R , the radius of the earth, is small as compared to unity. Along this upper boundary surface the air glides without friction, but the friction between the surface of the earth and the atmosphere is sufficient to prevent slipping. The temperature on the earth's surface varies with latitude only, and in accordance with a law expressed by a harmonic function of the second order. The temperature variation with altitude is assumed to follow the same law as for the conduction of heat.

Under these assumptions Oberbeck developed formulæ by which he computed the following components of motion of the atmosphere: (1) the vertical and meridional movements due to the difference in temperature between the equator and the poles; (2) the east and west movements due to the rotation of the earth; and (3) the meridional and vertical movements resulting from the rotational flow.

His results show that the atmosphere is ascending between the equator and latitude 35° , and descending between the latter parallel and the poles. The meridional movements are from north to south up to a little more than half the height of the atmosphere, and from south to north above that level. West to east winds generally prevail, increasing in velocity with altitude and reaching a maximum at about latitude 55° . They diminish to zero at the poles, and become minus or from east to west in the lower strata within the Tropics.

Oberbeck's circulation appears to accord more nearly with the observed facts than Ferrel's, since his eastward winds diminish to zero at the poles instead of attaining such excessive velocities as Ferrel's formulæ would seem to require. But Oberbeck's equations give enormous velocities for the wind at a little distance above the surface of the earth, unless we make the ratio $\frac{H}{R}$ very small, or the factor representing the internal resistance of the air very large.

It is thus seen that the theories of both Ferrel and Oberbeck are faulty, in that they suppose no temperature variation with longitude and attribute too great a retarding effect to internal friction. In fact on this latter point von Helmholtz⁴ has said:

² Motions of Fluids and Solids relative to the Earth's Surface, 1859, and Recent Advances in Meteorology, 1886.

³ Translated in The Mechanics of the Earth's Atmosphere. Abbe, Washington, 1891, p. 176.

⁴ Translated in The Mechanics of the Earth's Atmosphere. Abbe, Washington, 1891, p. 78.